

Implementation Brief ■

The Development and Implementation of a Software Tool and its Effect on the Quality of Provided Clinical Nutritional Therapy in Hospitalized Patients

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Abstract The authors developed “DIET”, a computerized system preparing dietary prescriptions in clinical settings. “DIET” has the ability to calculate the nutritional requirements and to produce daily menus of patients automatically. Also, it serves as an electronic medical and dietetic record and it can produce daily reports regarding portions, quantities and cost of meals. The authors also conducted a preliminary evaluation of the system by comparing the design of nutritional plans for 135 patients using “DIET” versus the customary manual methods. Its use resulted in a decrease of the error percentages, concerning appropriate food choices, data recording and calculations of daily nutrient requirements; from 12% to 1.5%. Additionally, there was a reduction by 50% of the time required to obtain and process data as well as design a patient’s menu. “DIET” implementation resulted in error decrease and thus in improvement of menu planning, accuracy and recovery of data and decreased the time spent on menu planning.

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Introduction

Malnutrition is a common finding in hospitalized patients and it is detected in 20–50% of the patients.^{1,2} Among other factors, malnutrition is associated with prolonged hospitalization and higher treatment costs.^{1,2} Correia, et al reported that the mean daily expense of malnourished patients was 90\$ higher compared with the costs of well nourished patients,³ while an increase in costs of 19% (200–1,500 Euros) associated with disease-related malnutrition has been observed by Amaral, et al.⁴ Nutritional support is the provision of adequate nutrients to maintain a healthy body weight and avoid undernutrition. Early nutritional support in hospitals has resulted in a positive correlation with the patient’s outcome.⁵ Also, systematic nutritional assessment

(assessment of whether the patient takes in all nutrients required) in the beginning and during hospitalization, has been shown to improve patients’ nutritional status.⁶ Adequate nutrition during hospitalization, is vital for ensuring fast recovery and improved quality of hospital stay for all patients. Thus, the nutritional support can directly improve patients’ nutritional status and indirectly (through the decrease of malnutrition complications) decrease the length of hospitalization. The healthcare systems underline the need for shorter periods of hospitalization and optimal management of healthcare in general and hospital expenditure in particular.⁷

Nevertheless, delivery of high-quality and cost-effective nutritional care to patients has been shown to be an increasingly difficult task.⁸ Studies in European hospitals revealed a wide variation in dietetic practice and services and serious deficiencies in some cases.^{9,10} In most Dietetic Departments in Greece, dietitians are requested to carry out the nutritional assessment, to manually calculate the nutritional needs and to design the everyday meal plan for each patient. In most cases, these time-consuming tasks are not completed due to lack of time or inadequate number of personnel. Thus, the everyday menus are not individualized and nutritional assessment is performed only for patients with visible signs of malnutrition. Therefore, the nutritional support is not always adequate and efficient.

Nutrition care managers have recently realized that the use of information technology improves the quality and effectiveness of the nutritional support services in clinical settings compared with the traditional manual methods.¹¹ As a result, this kind of technology has been introduced in hospitals.¹² A computer-based information system for nutritional care can also support the Food Services Departments’

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functional units that deal with the purchasing, production, menu planning, clinical management, meal service and preceding inventory control.^{13–15} Most of the software that has been developed for hospital Dietetic Departments, concern nutritional screening and assessment, assignment of tasks, distribution of workload among dietitians and data recording.^{16–18} Researchers have concluded that the use of computerized systems improves the quality of care and the clinical productivity in all fields mentioned above.^{16,17} However, the search of programs available for calculations of nutritional requirements and menu planning in hospitalized patients revealed little interest in evaluating the potential benefits of computer-assisted nutrition.¹⁹ Details of the algorithms used to develop these programs were reported only for computer programs that assist in the preparation of daily total parenteral nutrition formulas for adults and preterm neonates.^{20,21}

The purpose of this study is to describe the development of a software tool, “DIET”, and to evaluate its implementation in the dietetic department of a general hospital in Greece. The software has the ability to calculate nutritional requirements and to automatically design the menus for all patients, store patients’ data in records and produce reports on preceding food list and menu costs. We evaluated the effect of the implementation of “DIET” regarding the quality of nutritional care, efficiency of data collection, elimination of calculation errors and data loss, decrease in time spent for dietitians and technicians in comparison with the manual methods used for the preparation of dietary prescriptions. We also evaluated “DIET” software regarding the length of hospitalization.

Methods

Technical Details of the Program

The program was developed in Java programming language, and can run in Windows 95/98/ME/2000/XP or Linux. Minimum hardware requirements are Pentium, RAM 1 GB, free HDD 20 GB. It uses the client—server software architecture model, in which the client initiates a communication session, while the server waits for requests from any client. The server in the particular case is an RDBMS called MySQL. All the business logic has been implemented in the client side. The program contains the algorithms hardcoded used to implement the desired business logic. It is a free-standing software and it does not require any technical support from the hospital. It can be connected with the printers in all the departments of the hospital and data can be printed upon request. Factors that were considered before the designing of the program included: object orientation, platform independence, design, internalization, and application. Java was selected as the appropriate programming language because it is object oriented and platform independent. The software design provides flexibility and maintainability using the latest developments in programming technologies and design patterns such as ORP (Object-relational Mapping) and MVC (Model-View-Controller). The application was modified to support international data. All static text is configured on property files depending on their language. The application chooses the display language by “reading” the operation’s system default language. This provides the ultimate flexibility since no recompilation

of code is required for other languages to be supported plus the fact that all text is placed in one central area making it easier to maintain. User-friendliness was one of the major goals of the application design. Increasing and fast productivity of menus was also very important. By contrast, reducing the time required to learn how to use the program was necessary. For this purpose many widgets were used, such as the dynamically created popup list activated when the user starts writing the first letters of the patients’ name or the editable drop down box activated when the user enters a new food in the menu.

Algorithm for Designing Daily Menus

For daily menu planning, a database has been developed. It includes information concerning all the foods and recipes available in a hospital, as well as their analysis, in micro- and macro-nutrients. It also includes rules concerning foods that are allowed or prohibited in specific clinical cases and proper food combinations.

Main Modules of the Program

The main modules of this software are:

- i. the **database module**, which is used for patient data records (entering, updating and storing), provides two checklists, one for the diseases and one for the dietetic prescriptions, and contains a field for the daily menu plan.
- ii. the **maintenance module**, which is used for editing and updating the nutrient value of components, the cost of raw meal ingredients, the portion sizes and the food recipes.
- iii. the **statistic module** produces data sheet reports (e.g., reports of the preceding production, cost per menu, etc).

Development of the Software Program

The software calculates daily nutritional requirements and produces the patient’s daily menu. Menus that are automatically designed do not contain foods that have been recorded as food intolerances, allergies and dislikes and foods that are prohibited by the patient’s dietetic prescription or clinical condition. Also, dietitians are able to implement changes on automatically produced menus according to their judgment. The software is based on an electronic dietetic and medical record which can be updated at any instance.

The software produces output reports which concern the estimation of:

- the portion sizes and quantities of raw ingredients required for the daily preparation of menus (preceding food list),
- total daily cost of foods,
- daily cost per serving, and
- mean value of daily menu cost.

Validation of the Software Program

To control the functionality and accuracy of the software calculations and menu planning, the program was tested against manual calculations and menu planning. The manual procedures were performed by 4 dietitians of the Dietetic Department during a 3-month period. After this trial period and some important corrections, the software was proved to perform accurate calculations and construct appropriate menus (data not shown).

Preliminary Evaluation Methods

Study Population

Data were recorded from 135 adult patients admitted to the private general hospital diagnostic and therapeutic Centre of Athens (DTCA) "Hygeia" during a 3-month period (Jan–Mar 2007). Patients with different diagnosis, who required nutritional support per os, were included to examine a wide range of clinical conditions and nutritional needs. Patients receiving parenteral and enteral nutrition were excluded from the study. They were all referred to the Department of Nutritional Support and Dietetics of DTCA "Hygeia" by their attending physician. The study was approved by the scientific and ethical committee of the hospital.

Assessment

Data concerning height and weight was collected. All data on age, diagnosis, clinical condition, medication and medical history, was collected from the medical records. Also, data for hospitalization days for all the patients and the type of the incidence was gathered for Sep, Oct, and Nov for the calendar years 2006 and 2007. The use of "DIET" began in 2007.

Calculation of Nutritional Care Plan

Upon admission, a trained dietitian collected all data from each patient's medical record and copied them on forms (each patient's form was kept until their discharge). Next, the dietitian calculated the patient's daily requirements manually and developed a daily menu plan.

Following the manual development of the daily menu, all data collected by the same dietitian, was entered in "DIET". Then, the program automatically calculated the nutritional requirements and produced a daily menu. To avoid the between-person variability, the user of the software was the same dietitian that performed the manual method.

The time that the dietitian needed to record the medical and dietary history, to calculate the individual nutritional requirements and to design the daily menu, manually and using the "DIET" software, was measured with a stopwatch by another individual, who also monitored the whole procedure to record any errors.

Finally, we compared the time required for the two nutrition technicians to estimate the cost and the preceding food list, for both the manual and the automated method.

Statistical Analysis

Continuous variables were expressed as mean and standard error of the mean (SEM). Comparisons concerning time spent for each procedure (manual and automated) were performed using the independent sample t test. The same test was used to compare days of hospitalization between 2006 and 2007 (before and after the implementation of the software). All statistical tests were performed at $p = 0.05$ and the level of significance is two-sided. Statistical analysis was performed using SPSS 16.0 software (SAS Institute, Cary, NC, United States).

Observations

The type of errors observed included errors in food choices, contradicting the dietetic order or patients' preferences, errors during data recording and errors on calculations of daily requirements. The number of errors of manual versus automated method was 16 versus 2 errors, respectively. The manual method was prone to all kinds of errors considered

in the study, while errors detected when using the computerized method were on recording data only. This was a clinically significant decrease of 88%.

Significant differences were noted between the manual and the computerized method concerning the time required to retrieve data from medical and dietary records ($p = 0.01$), to calculate patients' needs ($p = 0.01$), and to design the menu ($p = 0.01$). The use of "DIET" proved to decrease the amount of time required for all these tasks. Prior to the use of "DIET", dietitians spent approximately 9.7 minutes of work time to complete all necessary procedures while the use of "DIET" reduced this time to 3.2 minutes (a decrease of 68%). Nutrition technicians usually spend 12 hours/day to estimate the preceding food list and the food cost, whereas, using the software, those lists are produced automatically and technicians need only to print the reports (a task that consumes 10 min/day).

There were no significant differences in days of hospitalization for all patients between September 2006 and September 2007, November 2006 and November 2007. The only significant difference was shown for October 2006 and October 2007, where the days of hospitalization in 2006 were significantly higher than those in 2007 (p value = 0.02). No difference was found for the days of hospitalization according to the type of incidence in any of the 3-month period in 2006 and 2007 (data not shown).

Discussion

Nutrition plays a key role in disease prevention and treatment, particularly during hospitalization.²² Recently, computerized nutrition support systems have been introduced in hospital settings to provide faster and more accurate care to patients.¹⁴ This study describes the development and evaluation of the implementation of a new software tool, the "DIET", on a general hospital in Greece. The program described herein makes the practical clinical knowledge easily accessible in the daily clinical routine of a dietetic department.

We observed that using the program, there was a clinically significant decrease in the errors observed during data recording, calculating daily requirements for each patient and designing daily menus. Thus, its use can ensure greater accuracy and safety in clinical practice, which is an effect of clinical importance. This result agrees with other studies, which showed decreases in the errors using software tools in clinical settings.^{23,24}

Statistically significant differences were found between the time needed to calculate nutritional needs manually and automatically using "DIET", thus demonstrating the advantages of the computerized method. Minimization of the time spent by dietitians to plan everyday menus allows for more time for direct patient care, screening, academic research and professional development. The use of "DIET" also minimizes the time spent on the food processing list and on the calculation of the total cost/meal by technicians, since these reports are produced automatically. Therefore, technicians could also be occupied in other tasks (e.g., systematic controls of the food service procedures). The advantages of the consequent time saving have also been indicated in other studies, which tested the effectiveness of software tools mainly in enteral and parenteral nutrition planning in intensive care units.^{25,26}

Finally, the use of "DIET" showed no significant advantages in decreasing the length of hospitalization. The data were significant only for 1 month before and after the implementation of the software and there was a tendency for a decrease of hospitalization days, in the other 2 months which did not reach significance. No conclusions can be made, but data collection will continue to assess the effect of "DIET" in the length of hospitalization for a bigger sample and for a longer period.

Implementation of "DIET" enables health professionals to overcome the burden of manual calculations, while it can also accomplish faster statistical analysis, record management, food preceding listing and cost calculation. It also offers a simple, fast and safe way of providing individualized nutritional support. The quality of nutritional services would certainly improve from its systematic application. Although the use of computer software tools may not always decrease staff needs, they are important to manage the large amount of information required for effective management of the departments.

As already mentioned, there are few other programs available for calculation of nutritional requirements and menu planning in hospitalized patients.¹⁹ These studies have shown similar results concerning some of the advantages of supportive software. To the best of our knowledge, there are no relevant publications. A web system for nutrition counseling and menu management has been described in a previous publication.²⁷ This system can be used by general population and health professionals, but not in clinical setting, to analyze foods, dishes, and menus. Also, it can compare each analysis with Korean Recommended Dietary Allowances.²⁷ However, this publication does not describe the implementation of the software and the possible effects of its use. Also, another computer program has been described for use in hospitals.²⁸ It has the ability to perform nutritional screening and to calculate patients' nutritional needs. It cannot, however, produce menu plans. Its implementation resulted in improvements in the nutritional condition of patients and in the productivity of dietitians.²⁸

In conclusion, the development of the "DIET" software has been an attempt for the development and implementation of a nutritional care computerized system. Improved safety and quality of nutritional care, decreased errors, continuous monitoring of patients, increased employees' productivity and automatic calculations of cost per meal on a daily, weekly and monthly basis, were some of the most important manifestations of the "DIET" software.

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